Dr. J. Robert Oppenheimer Praises Scientific Uses of '701

The IBM Electronic Data Processing Machines can serve as a needed substitute for experiment in certain scientific areas, Dr. J. Robert Oppenheimer, Director of the Institute for Advanced Study at Princeton, N. J., told 200 leading scientists and leaders in education, government, defense and business who attended a luncheon April 7 at IBM World Headquarters and the first public showing of the new highspeed calculator. IBM Chairman Thos. J. Watson, who presided, presented IBM President Thomas J. Watson Jr. and Dr. C. C. Hurd, Director of the IBM Applied Science Division, who later demonstrated the new machines in the calculator room.

Texts of the addresses of Messrs. Watson and Dr. Hurd appear elsewhere in this issue.

Mr. Watson said that introducing Dr. Oppenheimer to the scientists and educators would be like introducing the President of the United States to the Congress.

"You are all familiar with Dr. Oppenheimer's brilliant career," he continued, "his important participation in the atom bomb project, his able direction of the work of the Institute for Advanced Study, and his great record of service to his country, so that my pleasant duty in presenting him to you today is an easy one.

Cites Aid to Science

"There is one phase of his career, however, with which some of you may not be familiar, and in which I feel he has made a tremendous contribution to the achievements of science. When he joined the faculties of the University of California and the California Institute of Technology in the thirties, he surrounded himself with a group of young, full-time graduates who developed themselves into outstanding physicists under his guidance.

"When war came and the need for nuclear physicists became apparent, this group of young men became an important nucleus around which was built the scientific team which contributed so greatly to the war effort. The work of these men, and of those who felt their influence, constitutes a self-perpetuating contribution on the part of Dr. Oppenheimer to the advancement of knowledge and to the progress of our world.

"Ladies and gentlemen, I am honored to present to you Dr. J. Robert Oppenheimer, Director of the Institute for Advanced Study."

Dr. Oppenheimer spoke as follows:

"It is a pleasure to be associated in any way with this celebration; that is what we are here for today, to celebrate an extraordinary achievement. I need hardly speak of the magnanimity, in the true sense of the word, of Mr. Watson, that has made this achievement possible. I think I should give a word of real congratulation to the scientists and engineers who have brought a computer into existence which, as it comes into existence, is neither too little nor too late. This is a quite rare occurrence among computers.

"When I was asked to talk, I had the impression that the 'phone had rung in the wrong office at the Institute, and I said, 'Haven't you got the wrong number? Don't you want to talk to Dr. von Neumann down the hall?' 'No,' I was told, 'He really knows too much about this subject.'

"So it was clear to me my task was limited. I am to talk about the meaning of the computers in research, in new understanding of the world; I am not to talk about the immense prospect of their contributions to the defense program, of their contributions to industry, of their contributions to the solution of practical problems.

Tells of Ancient Computation

"The two are not too far apart. More than two millenia ago, compution was playing a very remarkable part in the life of Babylonia. There had been developed a most sophisticated and refined mathematical treatment of the raw data on lunar eclipses: purely as a mathematical problem without any mechanical model; without anything that we could call celestial mechanics. The problem the chaps had was to predict the next lunar eclipse and the next one after that, into the future. They learned the art of numbers so well that these same methods were still in successful use in India in the last century; and this, remember, was without any notion of the laws of motion; it was just from a study of the numbers themselves.

"But the analogy goes further, because they were not only interested in this because of the obvious practical value, to a society in which eclipses had some magic meaning, of knowing when they were going to occur, an ability to predict, so to speak, the local stock market; but the computations were also clearly followed simply because of the beauty of the occupation, because of the art and wonder of it; and it is perhaps that part that I am supposed to talk about most today. They are never separate in human life, and they will not be separate with the new computers of the International Business Machines either.

Substitute for Experiment

"The use of computation to extend understanding is, of course, not new. It characterizes the whole of scientific life in the last centuries. But there is something new about the high-speed computer. I want to oversimplify and almost parody what this is about by stressing one element of it. The high-speed computer, in certain areas, is a sort of substitute for experiment. It enables us to find out the connection between things in places where we have not the power (and I hope my examples will illustrate why) to make those deliberate, controlled changes in the state of affairs which are the normal way that we try to disentangle things.

"That is one pre-condition. And the other pre-condition is that the subject has to be mathematically kind of obstinate and tough. You do not want a high-speed computer for something you can do by the classic methods of analysis.

Used for Complex Problems

"In practice this means that one applies computers primarily to problems which are complex and which, in the technical phrase, are deeply non-linear. That means, in a non-technical phrase (and I hope my colleagues will forgive me for it), problems in which the effects are not the sum of the effects of the causes, in which every constellation of what actually goes on has a kind of uniqueness and cannot be put together out of similar simpler elements. Most of the problems that have yielded to high-speed computing, and many that are on the books for the future, have this characteristic, and in that they go beyond the familiar mathematics of the last centuries.

"I think I can illustrate this by taking three examples. Two are familiar in the sense that a lot of work has been done on them. The third is for the books, for the future.

"The first is the perpetual problem of weather. How does the atmosphere act? And this, as everyone knows, is a complex problem in strongly non-linear hydronamics. Great progress is being made in using rough information about the state of the atmosphere today to know something about the state of the atmosphere tomorrow—and that this will be of practical importance I need hardly add.

"What will come out of it, too, is that after the accumulation of experience, which in this case is not to take weather readings so much as to do calculations, and check them occasionally against weather readings to see whether you got the point of that particular situation, a new kind of order and simplicity will emerge, because we will know what makes a difference, we will know what is important, we will know what is trivial, we will even know (even though I think it in this case unlikely), whether we have forgotten some very deep or surprisingly new point.

"A second example, that is even more striking, it this; We from time to time get messages of immense stellar explosions which may have taken place some hundred million years ago. It is hard to do experiments with those things. No one can go back a hundred million years, and no one wishes to go out a hundred million years into space in order to learn what effect mankind, if he then survives, will see two hundred million years from now. And yet it is of great interest and excitement, and a challenge to man's imagination, to try to figure out what causes these great events. This is also a deeply non-linear problem, in all likelihood a problem where the fundamental laws are known, a problem where the mathematical unscrambling will be the payoff.

Aids Atomic Research

"The third example is a more modest thing, but also in its way striking, and that has to do with the state of affairs, not in an exploding star, but in an atomic explosion. Here I think a whole new tradition of the use of computers and of computational methods has been built up. And even today, when there have been a large number of atomic explosions, the inside of an exploding bomb is not a cozy place to observe; a great deal of the normal experimentation is foreclosed by that, and by the cost and cumbersomeness of the effort. Initially, there was a much stronger argument, in that we did not have enough stuff to make an explosion. Then the important proving grounds of atomic bombs were the paper proving grounds in which one tries to see what ought to be going on. It is a rare, though not an unheard of event, that what happens in Nevada and in the Pacific tells us something important and new, that had not been found in this immense prior effort at understanding. This has set, I think, one of the highest standards of analysis that has ever appeared in what we could call a generalized sort of engineering.

"In all of these efforts, one hopes for a lot. One hopes, first of all, out of the wealth of experience to get a simple view of what is at first quite a complicated phenomenon. One hopes that mathematics will eventually catch up in its full analytic powers with the experience that the computers give. One hopes to find out what the important elements of the problem are, and whether models work. And one hopes, above all, to find out if one has been a fool and left out the mainspring of the phenomena one has tried to investigate.

Useful in Genetics Study

"It seems clear to me that in the statistical problems of genetics and of population studies, as in studies of economic models, experiment is also going to be a very costly and perhaps a prohibitive thing; thus I would expect that in these fields, too, the availability of computers could be of unmeasured value.

"This is a new tool. It is a new tool, as was the microscope. It is a new tool, as are the tracers, the radioactive tracers, which have so recently become available to all branches of science. It is, as such a tool, a monument to man's reason, in two ways: to its limitation, because without experience, without massive experience, we never get the point; to its power, because once we have experience, knowledge cannot regress, science can never be retrograde. It is a tribute to deep modesty, and to the mind's high splendor."

IBM President Describes 701 Development

The work of IBM engineers and scientists to develop and manufacture the highly intricate IBM Electronic Data Processing Machines in the short period of twenty-four months was described at the New York luncheon April 7 by Thomas J. Watson Jr., IBM President.

Introducing the younger Mr. Watson, Thos. J. Watson, who presided, said that an idea and a personality were behind IBM's development of the new machines.

"The idea back of the new calculator was to build machines that would go far beyond anything that the company had accomplished before," he said. "And the personality behind the new machines was Thomas J. Watson Jr., President of our company. He has followed the development of the new machines, sometimes day and night, from the very inception of the idea. He has taken the entire responsibility for the executive staff all the way through. This was an extra project assigned entirely to him and he has carried it through in a way that has made all of us happy and well satisfied with the result.

Presents IBM President

"I present Thomas J. Watson Jr., President of IBM."

The IBM President said that it was a difficult task to follow Dr. Oppenheimer with any discussion of mathematical computers because of the honor guest's great authority in such matters.

"My discussion will be confined to just how the new machines were developed in our business," he said. "Following my remarks we will go downstairs to the calculator room to see how the machines actually work.

"As Dr. Oppenheimer has explained, men have been trying to simplify and mechanize arithmetic problems for thousands of years. The machines we present today constitute another step along the way, and not the last step.

"As you enter the calculator room please notice the Pascal computer which is mounted at the left of the entrance. This computer was built 300 years ago by the son of a French customs collector who was kept up late nights figuring customs duties. He invented a machine to solve the problem, a simple machine which probably was the first mechanical computing machine to be built. The principle of the big machines you will see demonstrated is essentially the same as the principle of that first machine. Over the years man has added capacity, flexibility and speed, but nothing more.

War Heightened Demand

"After World War II the demands for automatic computing increased tremendously. We had a tremendous shortage of mathematicians and engineers. Employers wanted to free their staffs for conception rather than repetitive thinking, and it was particularly important that the prototype model of a missile, an airplane or a jet engine work correctly, because of the very high cost of producing that prototype.

"For example, in the aeronautical field, where this machine will do much work, the prewar airplane required 70,000 man-hours of engineering. In the postwar airplane, a little bigger, 12,000,000 man-hours of engineering were required. That gives you an idea of the problems that exist in the areas in which we work.

"The tremendously increased cost of engineering and computation required new tools, and in the period from 1946 to 1950 IBM built a number of partial answers. We have some 1,200 electronic computers of medium size in the field at the moment, and these computers heightened our knowledge of the field and heightened the desire on the part of a few customers for a much more powerful tool.

"After the start of the Korean crisis, greatly increased defense activity in the aircraft, the atomic energy and the munitions manufacturing fields increased the demands for machines capable of engineering computations of the highest order. IBM was anxious to contribute in any way it could to the defense effort.

Research Is Expanded

"Our electronic research had expanded greatly after the war, and by 1950 our people felt they had components which, if put together, could make the very large capacity tool that industry wanted. We developed a paper plan and decided perhaps we could get interested people to indicate to us that they wanted such a machine. Our engineers made a trip to the West Coast and came back with tentative orders for eighteen. Then, because of the complexities of the problem, the engineers and mathematicians of the people who were going to buy the machines sat down with our own engineers and scientists and agreed on the desired operating characteristics of the machines.

Handles Tough Problems

"Many of you may wonder how long it will be before these machines will be in use in your office. At present the new machine is so costly to build that you must have a complicated problem before it is applicable. As Dr. Oppenheimer said, the problem must be obstinate and tough. If any of you have obstinate and tough problems we will be delighted to apply a machine to them.

"As transistors and other types of components make this equipment less expensive, we think the office equipment industry will present machines which will be applicable to many jobs which are not now mechanized.

"Our scientists, engineers and production people have an unusual record in the production of these machines. Just twenty-four months ago one of our scientists sat down in my office and said, 'I think we could do such a job.' At that point the machines were not even on paper, but now, twenty-four months later, we are presenting the second machine we built.

"I would like to mention by name all of the scientists who contributed to the machines. Many of them are sitting with you at your tables. But I am afraid that the time is too short, as we want to show you the machines.

"The machine will be demonstrated by Dr. C. C. Hurd, Director of our Applied Science Division. Dr. Hurd came to IBM from the Atomic Energy Project at Oak Ridge, where he was one of the research directors. He has been a tremendous help in the scientific side of our business, and he is able to make these complex machines and the complex problems they do sound relatively simple, which is no mean task.

"Dr. Hurd's demonstration will take just a few minutes, and for the rest of the afternoon he and his associates will be available to answer any questions of the scientists who are here.

"We thank you very much for coming, and thank you for your attention."

IBM Engineers Designed and Built '701' Calculator in Record Time

Cognizant of the urgent need for an improved electronic calculator with greater speed, storage capacity and flexibility than existing machines, and which could be produced commercially to solve complex problems of the defense effort, Thos. J. Watson directed the attention of the IBM engineering and research organization at the start of 1951 to the development of what was to be the IBM Electronic Data Processing Machines.

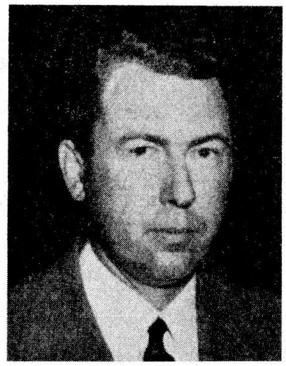
Throughout the intensified program of research and development which produced the new calculator in record time, top executives at World Headquarters and at Poughkeepsie served in a planning, consulting and advisory capacity. These advisors included Thomas J. Watson Jr., IBM President; W. W. McDowell, Director of Engineering; J. W. Birkenstock, Director of Product Planning and Market Analysis; R. L. Palmer, Manager of the Poughkeepsie Engineering Laboratory, and Dr. C. C. Hurd, Director of the Applied Science Division.

Planners, Consultants on Calculator

W. W. McDOWELL

J. W. BIRKENSTOCK

DR. C. C. HURD



R. L. PALMER